Central States Archaeological Journal

VOLUME 50 SPRING, 2003 NUMBER 2

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On our cover

The Corn Woman Effigy Pipe was found in Desha County, Arkansas, about 1970 by Harvey McGee. Most experts agree that this pipe was manufactured in the Cahokia Mounds area in Madison County, Illinois, and was exported to other important Mississippian centers. It is 7 1/2 inches tall and 7 1/2 inches long. From the collection of Dr. Kent Westbrook. This artifact was chosen by our Arkansas society to represent Arkansas on our cover.

Central States Archaeological Journal

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RED METAL POUNDINGS AND THE "NEUBAUER PROCESS": COPPER CULTURE METALLURGICAL TECHNOLOGY

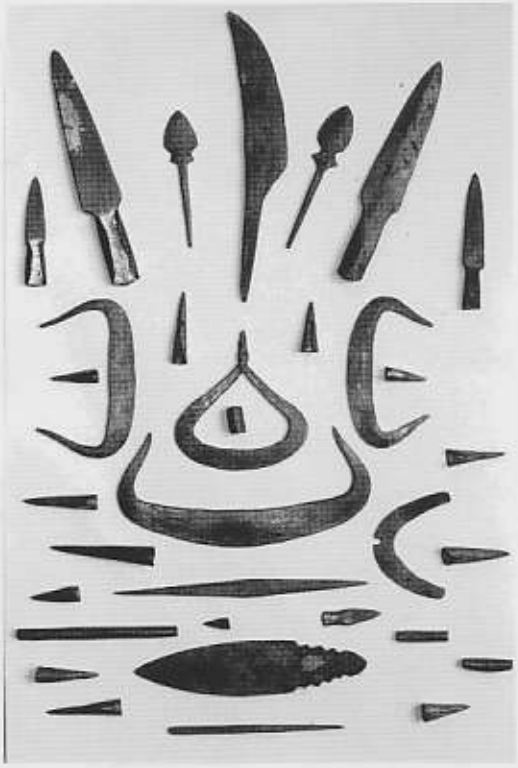
David H. Peterson
Two Harbors, Minnesota

The Lake Superior ancient people's lost metallurgical technology used to manufacture copper tools and ornaments is being rediscovered one pounding at a time. The ancients left behind hints and traces of their industry and culture stretching back 6,800 years BP at South Fowl Lake, Minnesota (site 21CK1) in the form of copper and lithic artifacts and important worksite debitage. The French, British and Yankee mineral explorers from 1600 through the 1880s, including interested people today, have all marveled at how these tools could have been made using only fire and hammer.

No known kilns or crucibles capable of melting or smelting native copper have been found in the Lake Superior Basin, yet tens of thousands of artifact copper tools, ornaments, worked debitage and rock hammers have been found, provenienced and historically written about since the French in 1620. If smelting were to have occurred, then one would assume some forms of smelting kilns and crucibles would also have been found. As research continues into the future, more information will undoubtedly change our present knowledge; however, the mysteries of ancient copper production are subject to much curiosity, marvel and academic debate.

Amateur and professional experimental metallurgists and archaeologists have attempted the rediscovery of ancient copper tool manufacture. The awe and curiosity elicited by carbonated (found in situ with soil or charcoal from ancient fire pits) and oxidized (found in situ in water) artifacts have been the stimulus to reproduce ancient copper tool forms. The ancient tools were often associated with copper mining pits hammered from amygdaloidal copper deposits or excavated from glacial till in the form of "float"or simply as nuggets found in eroded stream beds of the Lake Superior Basin. Michigan's Upper Peninsula has abundant native copper deposits of amygdaloidal crystal and floats and has the highest frequency (with the exception of northeastern Wisconsin) of ancient tool discoveries by today's rock collectors and amateur and professional archaeologists.

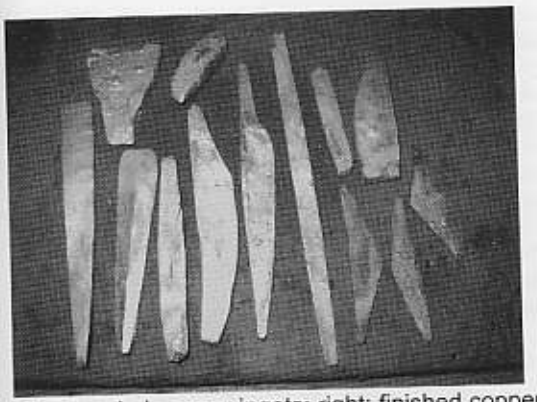
Joseph Neubauer Sr., age 81, of Pine City, Minnesota, who has been affected by the Miskwabic spirit, has studied for over six decades to understand the mysteries of copper tool manufacturing. Joe discovered the Northwest Company's 1804-5 wintering post on the Snake River near Pine City, Minnesota, in 1932 and reported this discovery to the Minnesota Historical Society shortly after returning from WW II. This historic site (21PN11) was excavated and reconstructed by Dr. Leland R. Cooper, archaeologist, Hamline University, in the 1960s. Prior to the site's excavation, Joe had also found evidence on this site of copper usage including socketed and conical points, one bead, awls, debitage and

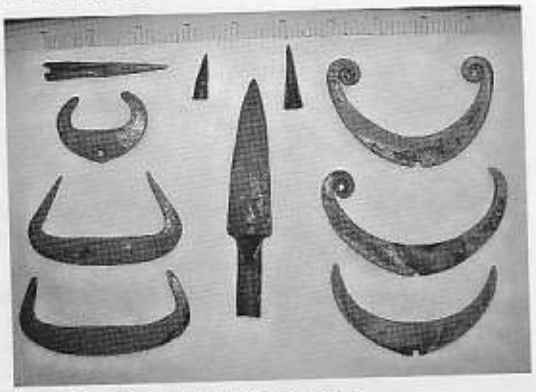


Using primitive tools and his knowledge of metal working, Joseph Neubauer Sr. made these copper tools.

worked pieces, plus lithic evidence dating back possibly 10,000 years. Joe also discovered an ancient copper worksite near Beroun, Minnesota, the Robert-Debra Neubauer Site (21PN86). These important discoveries and others, plus his family legacy in blacksmithing dating back to his grandfather Julius's Prussian Army metal smithing, and Joe's personal experience of sixty five years as a metal smith have led to a unique marriage with native copper crystals, float, half-breeds and arsenic copper (Mohawkite). In 1998 Joe was introduced to Ken Flood, Michigan Technological University geology graduate and owner of the Keweenaw Gem and Gift, Houghton, Michigan, who encouraged him to sort through thousands of float and mineralized carbonated specimens. From these culled native copper specimens, Joe has reproduced over three hundred finished ancient tool and ornament duplicates, including twisted-stem-handled ulus, deep-socketed and shouldered spuds, knives, and spear points of over twenty authentic shapes and forms. Joe has three white-oak-ember fire beds for annealing when seriously experimenting in order to provide more time on task. The entire process that is described and applied by Joe is termed the "Neubauer Process."

Joe has studied academic literature, museum





Left: annealed copper ingots; right: finished copper tools illustrating the Neubauer Process.

collections, and private collections of copper artifacts, including the comprehensive Wisconsin collections of Dr. Earl Johnson and Gordon Morris. A colleague and amateur archaeologist, Dr. Tony Romano, Pine City, Minnesota, has been a frequent companion sharing ideas on possible metallurgical processes.

Dan Koss of Michigan and Gordon Morris and George Weimer from Wisconsin have provided valuable geographical information that has led to Joe's studying float locations in Upper Michigan and Wisconsin. Tom Amble, Minnesota Historical Society, and David H. Peterson have been mentors encouraging documentation of the "Neubauer Process." Joe is often heard to say, "To those who care, share, and compare without academic nonsense, I give my sincere admiration, appreciation and a hearty thank you." Since Joe began experimenting with copper, these and many other friends say to Joe, "Thank you for attempting a manufacturing process we know not of nor have the time to attempt ourselves."

Since 1999, when Joe began seriously experimenting with native copper, some of his original theories about copper tool construction have changed following more than four thousand anneal-pound cycles. The ancients and Joe learned that the final product resulted from the manner in which native copper must be worked. The copper nugget's original characteristics prior to manufacturing lead to the end result, and its physical properties must be followed. The average finished reproduction requires fifteen anneal-pound cycles with complex styles such as twisted-stem-handled ulus requiring up to thirty cycles. Several major discoveries, such as creating copper surface bubbles with white oak ember annealing, have been documented and duplicated several times. Dozens of artifact reproductions have been displayed for public and professional analysis, including ingots and final reproductions exhibiting the bubble trait with silver inclusions.

A four-year experiment in Michigan crystal float copper, Mohawkite and silver half-breed float annealing and pounding into all categories of the Warren Wittry Classified artifacts has been accomplished. Joe, a professional metal smith with sixty-five years of experience and WW II Navy Metalsmith First Class, with science studies at Marquette University, Milwaukee, and University of Wisconsin, Madison, whose grandfather and father were blacksmiths, has devoted the last four years to rediscovery of metallurgical techniques possibly used by the ancients in their magnificent and unique tool and ornament processes.

This presentation is for the purpose of encouraging further study in the annealing by white-oak embers and shaping by pounding of native copper specimens and to stimulate youth to further scientific research to pursue the mystery of the ancient's copper manufacturing process.

The "Neubauer Process" of native copper manufacturing is condensed for review as a synopsis representing over three hundred reproductions, over four thousand anneal-pound cycles, and three thousand labor hours over the last four years. Following are Joe's observations learned during the process:

1. Select float specimens with a solid mass. This is very difficult to determine with green carbonate patina. Many apparently solid specimens are discarded after the first anneal when carbonation and/or oxidation is reduced by intense heat, allowing flaws and cracks to be observed. These flaws and cracks are mineralized elements (other than copper) or molecular minerals such as calcite.
2. Select floats of correct size. Cutting float to size by chiseling or hammering against a sharp gabro or basalt rock edge is a very difficult task. Copper is very malleable after annealing but remains very tough to chisel and cut.
3. Anneal the float to a red-hot glow on a white-oak ember bed. The length of time an ingot's red glow is maintained is not critical.
4. Cool the ingot by submersing in cold water or by merely pulling from the embers and allowing time to return to environmental temperature. The majority of this study was accomplished by cooling rapidly in cold water.
5. White-oak embers are hot enough to sweat or melt out silver in half-breed specimens, and the liquid silver atoms may form a sweat weld between copper ingots if lying in a contiguous state. Melt points are copper at 1981F and silver at 1761F (Kitco.Com). All annealing on embers occurred at approximately 950 feet above sea level at Joe's home near Pine City, Minnesota.
6. Arsenic nuggets (Cu3A5 or Cu6A5), com-

monly termed Mohawkite, are determined after the first or second anneal cycle by either a goldish or pinkish color and are discarded from further manufacture. These arsenic alloys are too brittle to shape by annealing and pounding. The specimens break up into smaller factions without the ability to flow and shape the ingot. Mohawkite was fortunately rarely encountered; however, it is disguised by green carbonate patina when found in float state.

7. Pound annealed "cold" float and resulting ingot into itself to form an approximately rectangular cube shape or a trapezoidal wedge cube shape. This stage may require numerous anneal-pound cycles depending upon the original float shape. A rectangle flat sheet ingot is required for rings and beads. A square cross-section ingot is required for awls, long fishhooks and pikes.

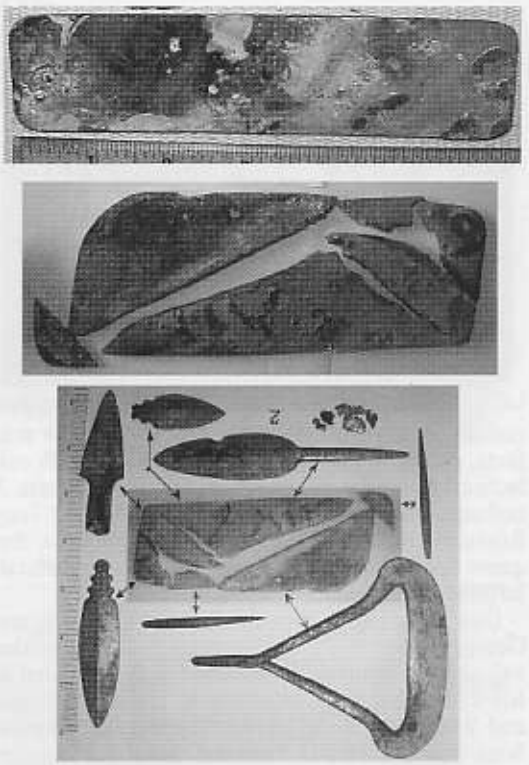
8. Ingots pounded in the cold state exhibit the same malleability as those pounded while in the red glow state and are much easier to handle when cooled in cold water. Hot ingot pounding reduces the number of anneal-pound cycles required to reach the final tool form. Hot ingots seem to retain malleability and can sustain more impacts than cold ingots, suggesting that hot ingots continue to realign molecular structure, allowing for "soft" malleability even when being pounded.

9. Pound annealed "cold" float or ingot until a ringing sound is produced or when the copper stops flowing with each impact. If pounding is continued when brittle, molecular cracks will develop which render the ingot useless for further forming of the intended final tool form. Throughout the entire anneal-pound cycles, a fine ruby red unknown dust is produced. This dust may be cuprite Cu2O, formed from the copper by the intense annealing heat combined with atmospheric oxygen.

10. Once an ingot's cubic shape is obtained, then further anneal-pound cycles will "flow" (push) the copper mass into the shape required for the intended tool. A rectangular cubic cross-sectioned ingot is substantially reduced in diameter, with the original length/width being pushed or made to flow from three to ten times the original length. The size and minerals or elements of the original ingot will determine the type and size of the final tool form.

11. The flow of copper by pounding is comparable to practicing with a rectangular cube of clay and pounding it with a small hammer. Clay, of course, does not become brittle and does not need the annealing step. The hammer impacts when correctly placed on the clay cube move (flow) the semi-fluid clay (similar to annealed malleable copper) into the new manufactured form (observation by Peterson).

12. Ingots are worked into form primarily through the anneal-pound cycle with the surface form often made by swedging the ingot upon an anvil of ungulate foreleg bone, antler base, hardened copper mandrel, convex or concave surfaced hard rock or specially formed hardened copper forms.



Photos showing the "Neubauer Process" from the ingot to finished tools.

13. Bending through application of force on a lengthened portion with the opposite side of the ingot held in an anvil rock crack is utilized for some ancient tool forms, e.g., twisted-ulu-handle stems, This is an example of one possible method.

14. In all experimentation, grinding for the final form, if necessary, has been applied with Jacobsvlle sandstone from the Keweenaw Peninsula. Hard sharp edges for knives are produced with a final pounding followed with minor touch up grinding. Other abrasive sandstones may be used effectively.

15. Ingots may fail with fatal cracks developing due to impure (minerals other than copper or silver) sedimentation anytime between the first and last anneal. Microscopic layers of calcite, epidote, peridotite, feldspars and arsenic may be the suspected impurities that produce this fatal flaw condition.

16. Portions of failed ingots may be salvaged into simple tools such as awls, fishhooks, staples, rivets and thumb scrapers. Many ingots demonstrate numerous scales or minor projections that need to be chiseled, pried off or ground off and discarded. The experimentation has produced hundreds of debitage that mirror ancient copper worksite in situ debitage discovered at the Robert-Debra Neubauer Site (21PN86).

17. The anneal-pound cycle may be repeated up to thirty times to achieve the tool's final form. The diamond cross-section knife or spear-blade design is one of the most difficult forms to achieve; however, several have been manufactured after very, very careful hammering.

18. Complex tools such as twisted-handle-stem ulu knives and deep socketed or shouldered knives have been pounded from half-breed (copper-silver) nuggets that maintain in final tool form the silver inclusion of the original nugget. This is accomplished by carefully controlling the white-oak-ember bed heat; e.g. not allowing the silver to melt out of the original copper mass. Maintaining a system to control the airflow over the ember bed is critical. Several half-breed specimens have had the silver inclusion completely melted out when close attention was not provided to control the embers' intensity (natural air flow).

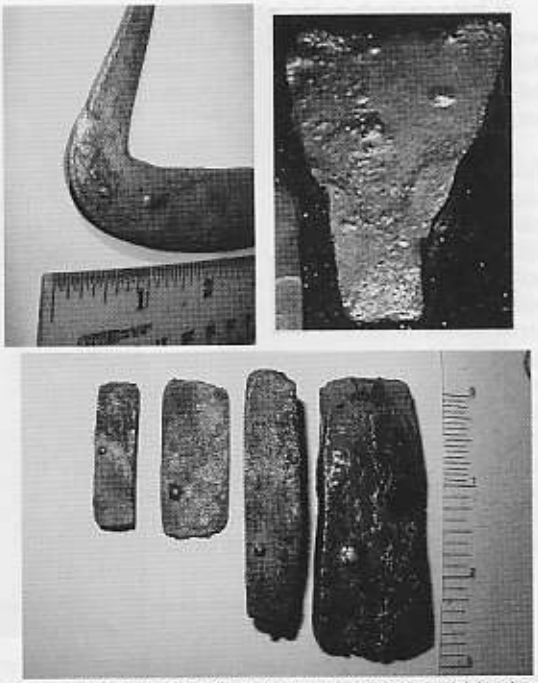
19. Gas bubbles on the surface of several pounded and annealed ingots and also on completed tool forms are documented with silver inclusions remaining intact throughout the main body of the ingot or final tool form. This demonstrates that copper smelting is not required to produce the gas bubble trait. If the tool had been smelted, this distinct silver inclusion could not exist in the final ingot or tool form.

20. Several completed tool reproductions exhibit the raised copper bubble formed from gas expanding and attempting to be released from within the red hot copper mass. These bubbles are observed at any cycle and have often been observed near or at the last anneal-pound cycle. In an ulu's case, this represents thirty cycles before a gas bubble may develop on the tool's surface. Great care was taken by the experimenter not to pound these bubbles back into the form's mass; however, the ancients usually, probably without any hesitation, pushed the copper bubble back into the tool's form for strength and aesthetic styling of the tool being manufactured.

21. With skillful application of the "Neubauer Process," ancient tool forms can be annealed and pounded. Smelting has not been necessary to create complex tool and ornament forms with the intriguing gas bubble phenomenon.

Major conclusions can be summarized as follows:

Ancient copper artifact forms can be annealed and pounded. Smelting or melting is not required. Arsenic copper specimens cannot be pounded into a new shape due to brittleness and cracking. A difference in copper specimen malleability exists between hot and cold pounding. Hot ingots continue to realign their molecular structure even while being pounded and can therefore absorb a significant increase in the number of impacts made prior to returning to existing environmental temperature. However, hot ingots are very difficult to physically handle. Physical and mechanical application of force vectors and techniques utilized in the "Neubauer Process" include grinding, chiseling, pounding, bending, drilling, swedging, application of mandrels, reaming and controlling the ember bed temperature (wind, draft or air flow caused by the fire itself). The diamond-shaped cross section found on rare ancient knife blades and spear points provides tool blade strength but is a very difficult manufacturing process to complete. This blade cross section was manufactured with much patience and very careful hammering; and due to the characteristics of copper, the same was probably true in prehistoric times. Copper can be shaped by swedging against rock surfaces, ungulate foreleg bone, mammoth tusk, hardened copper mandrels, hard wood and specially formed, hardened copper forms.



Copper ingots showing the mysterious bubble that sometimes forms on copper ingots.

Additional Experiments Underway

Twelve nuggets have been selected and some have been manufactured into reproductions. Each nugget and its characteristics during the anneal-pound cycles, including the resultant debitage and final tool forms, have been journaled. Selected ingot stages leading to the final tool reproductions have been photographed.

White-oak embers produce heat high enough to extrude fluid copper bubbles on the ingot's surface from the foreign mineral or elemental gas released from within the ingot. The bubble trait is rare because most gas is released through the cracks and crevices normally found in native copper mass.

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Silver melted in high temperatures can sweat weld copper ingots lying contiguous on the ember bed. This characteristic has also been demonstrated while using an iron tube container, for convenience, in which the ingot is annealed.

Artifacts that appear layered may not have been folded from a single flat-pounded native copper sheet (ingot). The common theory of a flat sheet of native copper being folded upon itself to make a thicker artifact may not be correct, as apparently solid nuggets when annealed and pounded often resemble a folded cross-section. Joe has demonstrated that apparently folded reproductions are not and, in fact, are produced from visually solid nuggets, which have sedimentary deposits of a mineral element (calcite, epidote and arsenic are suspected) that produce flaws. Some flaws are microscopic and are not observable until the late stages of the anneal-pound cycles. Specimens with visible flaws which are used from the first anneal-pound cycle to the final form will exhibit, under cross section examination, a folded appearance. This is due to the compression of the various original imperfections and layers of mass found within the specimen and not by folding of a single thin sheet ingot.

Related Observation:

Copper-bearing rock occurs along the Snake River, Pine City, Minnesota, from the outlet of Cross Lake and extends for several miles downstream. Native copper weighing from ounces to one hundred forty pounds has been found, and Joe has personally found an ancient copper knife and a 2 1/4 pound specimen.

Acknowledgments

Joseph Neubauer Sr. and associates
Advisors:
Kenneth Flood, Houghton, Michigan
Bergstrom Associates, Mora, Minnesota
Tom Amble, Minnesota History Center, St. Paul, Minnesota

Fish bowl effigy pot found by Wade Oldham at the Sandy Woods site in Scott County, Missouri. From the collection of Ron Smith of Calvert City, Kentucky.

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